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COMPARISON OF FOUR UNATTENDED GROUND SENSOR DISPLAYS

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and

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BATTLEFIELD INFORMATION SYSTEMS TECHNICAL AREA

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The Battlefield Information Systems Technical Area of the Army Research Institute is concerned with human factors problems of surveillance information presentation and interpretation. The research presented here compared the relative effectiveness of four different unattended ground sensor (UGS) displays--an X-T plotter, and three variations of the situation map display--in terms of their effect on monitor performance.

Four two-hour UGS scenarios were compiled from previously recorded field

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20. tests of military targets. The recordings were played back to activate the displays during experimentation. Sixteen Naval personnel (eight relatively experienced with UGS and eight inexperienced) were given training on the displays. Each subject then monitored each display in turn for two hours, reporting target information as he would operationally. The reports were compared to known ground truth and were scored on total detections, false alarms, detection accuracy, and target direction (i.e., direction of target movement).

Operator performance was unaffected by the type of display used. Operators were able to detect a higher percentage of targets during periods of low target activity than during periods of high target activity. However, the accuracy of the detections was higher during the high activity period. Levels of experience did not have a significant effect on performance.

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FOREWORD

A field of special interest to the Battlefield Information Systems Technical Area of the Army Research Institute for the Behavioral and Social Sciences (ARI) is that of human factors problems of surveillance information presentation and interpretation. One source of surveillance information is remote monitoring by unattended ground sensors (UGS). When an unattended ground sensor is activated by personnel or vehicle movement in its vicinity, a monitor display elsewhere indicates the activation. The research presented here compares the relative effectiveness of four different UGS displays--an X-T plotter and three variations of a situation map display--in terms of their effect on monitor performance. It is part of a continuing ARI program on factors affecting performance of operators monitoring remote sensing devices.

Work was done in cooperation with the Combat Surveillance and Target Acquisition Laboratory of the U.S. Army Electronics Command (ECOM/CSTA) at Fort Monmouth, N.J., and is responsive to special requirements of Army Project 1X763723D101 and of the Office of the Assistant Chief of Staff for Intelligence. ARI research in this area is conducted as an in-house research effort augmented by contracts selected for their unique capabilities and facilities for specific research tasks. The present project was conducted jointly by personnel of ARI and HRB-Singer, Inc. of State College, Pa.

J. E. UHLANER
Technical Director

COMPARISON OF FOUR UNATTENDED GROUND SENSOR DISPLAYS

BRIEF

Requirement:

To compare under operational conditions four different types of unattended ground sensor (UGS) displays, the RO-376 X-T plotter and three variations of situation map display, in terms of their effect on monitor performance.

Procedure:

The RO-376 X-T and the three situation map displays--a blinking light to indicate an activation, a light that increases in intensity with each additional activation, and the latter light plus the capability of reviewing previous activations in compressed time--were compared in terms of operator performance. Four two-hour UGS scenarios were compiled from recorded field tests run at Fort Bragg, North Carolina, using typical personnel and vehicle target patterns, noise sources, and two levels of target activity. The recordings were played back to activate the displays during experimentation.

Sixteen Naval personnel (8 relatively experienced with UGS and 8 inexperienced) were given training on the displays. Each operator then monitored each display in turn for two hours, reporting target information as he would operationally, except that prepared report forms were used. The reports were compared to known ground truth and were scored on total detections, false alarms, detection accuracy, and direction of target movement.

Findings:

Operator performance was unaffected by type of display used. Operators were able to detect a higher percentage of targets during periods of low target activity than during periods of high target activity. However, accuracy of detection was greater during high target activity. Levels of experience, time effects, and scenarios did not have a significant effect on performance.

Utilization of Findings:

The performance data from this effort provide the best available estimates of expected operator performance until more extensive field data are available. Typically, in the selection of type of display for a given objective, operator performance with available displays should be a major criterion used. In the present experiment, however, type of display was shown not to affect operator performance and thus offers no basis for differentiating among displays. Other measures, such as cost and availability, can provide added basis for selection of displays.

COMPARISON OF FOUR UNATTENDED GROUND SENSOR DISPLAYS

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COMPARISON OF FOUR UNATTENDED GROUND SENSOR DISPLAYS

BACKGROUND

One of the primary unattended ground sensor (UGS) monitor displays currently used by the Army is the X-T plotter (usually the RO-376 or Bass III Sensor Display Unit). These X-T plotters, by means of either 30- or 60-pen recorders, portray time vertically. Activations of sensors are shown by short horizontal lines in specified columns, each column portraying the return from a single sensor. This permanent record, plus information as to where the sensors are deployed, how far apart they are, and what type of sensor is being used, enables the operator to estimate when an enemy activates a sensor, where the enemy is, in what direction he is going, and at what speed. Because the record is permanent, the operator's report can be checked.

An alternative UGS display (the situation map display) consists of 30 lamps, each lamp linked to an individual sensor in the sensor field. Upon activation of the sensor, the corresponding lamp is illuminated at a predetermined blinking rate for a period of five seconds. After a five-second dormancy, the lamp again is able to light up if the corresponding sensor is again activated. Previous experimentation with this display[1] had revealed certain shortcomings. Subsequently, several variations of the map display were proposed and configured by the Combat Surveillance and Target Acquisition Laboratory (ECOM/CSTA), Fort Monmouth, New Jersey. The lamps in this display were situated beneath a scaled sketch map of the actual sensor field. The lamps were placed at points which represented the actual deployment locations of the corresponding sensors. An advantage of this display is that it aids the operator in identifying quickly the location and direction of movement of the source of activations by permitting direct simultaneous observation of the map and activating points.

Subsequent to the development of the map display, researchers incorporated the use of a playback unit into the system. This innovation allows the monitor to review previous activations on the display at his option. This reviewing process was conducted in compressed time, i.e., a shorter period than real time. The rate of 8 X real time has been most commonly used.

A more recent variation of the map display features an exponential lamp driver circuit. Basically, this circuitry increases light intensity in the lamp with successive sensor activations. In addition, a slower

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[1] Martinek, H., Hilligoss, R., and Lavicka, F. Comparison of three display devices for unattended ground sensors. ARI Technical Paper, in press.

decay of light magnitude provides a sustained signal for a period of time following sensor activation. Consequently, a temporary record of recent activations is provided the monitor.

To evaluate these developments, an objective assessment of the displays and their effect on monitor performance was necessary. In addition, since previous research had been based on the string, or trail, deployment of sensors, it was possible that different results would be obtained if a different deployment technique were used. To check this possibility, a new sensor deployment technique, area deployment, was used to drive the displays. Briefly, area deployment consists of sensors deployed in a grid (Appendixes A and B) across a designated area as opposed to the sequential alignment in the sensor string technique. Area deployment is intended for large areas where coverage by radar or other means cannot be used. It is designed to detect enemy forces intruding into a given geographical area, in contrast to the sensor string technique which is employed along trails or roadways.

OBJECTIVES

1. To determine the relative effectiveness of several UGS display devices under typical operational conditions. The displays to be compared were: (1) the RO-376 X-T plotter, (2) the situation map display with blinking lights, (3) the situation map display with exponential lamp driver, and (4) the situation map display with exponential lamp driver and compressed time playback capability.

2. To determine how target activity, time effects, and operator experience affect operator performance and the relative effectiveness of the displays used.

3. To determine the approximate level of operator performance using the area deployment of sensors.

METHOD

Population and Sample

Army enlisted UGS operators who have been trained at the Combat Surveillance and Electronic Warfare School, Fort Huachuca, Arizona and who have had some field experience constitute the population of concern. In view of the difficulty of obtaining a sufficient sample of experienced Army personnel at one location, school trained Naval enlisted personnel who had had field experience on several maneuvers were used. In addition to that experience, two hours training was given on the various map displays and the interpretation of area deployment sensor activations. A total of 16 Naval personnel served as subjects.

Equipment

The RO-376 X-T plotter simulator consists of a viewing window and a drive mechanism that presents sensor activation data exactly as the information would appear on the actual RO-376 (40 channels were used to represent two 20-sensor fields). Previously prepared X-T plots were displayed on this simulator. The three situation map displays used in the experiment were configured at the Combat Surveillance and Target Acquisition Laboratories, Fort Monmouth, N.J. The map display with compressed time used a recorder equipped to operate at a speed of 8 X real time, at the subject's option. All three were driven by tape recorders. On all three displays, 40 lamps were used, representing two 20-sensor fields.

Research Design

The 16 subjects monitored each of the four displays during four two-hour sessions. Four two-hour scenarios were prepared so that no subject would observe the same scenario more than once. Each scenario contained two half-hour segments of high activity (9-14 targets) and two half-hour segments of low activity (2-5 targets). A Graeco-Latin square design provided balance of displays, scenario, and order of presentation (Appendix C).

Variables

Independent Variables. The independent variables were:

1. Displays. The RO-376 X-T plotter simulator and three different situation map displays.

2. Target density level. Low density level (2 to 5 targets per half hour) and high density level (9 to 14 targets per half hour).

3. Operator experience. Subjects were assigned to groups on the basis of their field experience with UGS. Two groups of 8 subjects each, one relatively experienced and one relatively inexperienced, were tested. Group membership was determined on the basis of supervisor's ratings. A questionnaire completed by the subjects showed that the low experience group had had almost no experience with UGS beyond Service School attendance and that the high experience group averaged over a year in field experience.

4. Periods. Each operator worked for a total of four 2-hour periods.

5. Scenarios. Each operator observed each of the four scenarios.

6. Order of displays. Order of presentation of the four displays was systematically controlled.

7. Order of scenarios. Order of presentation of the four scenarios was systematically controlled.

Dependent Variables. The dependent variables were:

1. Correct detection. If an operator reported a target at the time a target was activating the designated pens or lamps of the display, the response was classified as a correct detection.

2. False alarms. If an operator reported a target at the time no target was activating the designated pens or lamps of the display, the response was classified as a false alarm.

3. Accuracy. Ratio of correct detections to total number of targets reported by the operator.

4. Correct direction. If an operator reported the actual route of a given target, the response was classified as a correct direction response.

Scenarios

The scenarios were developed from recordings of personnel and tracked and wheeled vehicle field runs conducted at Fort Bragg, North Carolina in April and May of 1973. Records of a total of 40 seismic sensors of the more than 130 deployed were selected to be used in developing four test scenarios (A, B, C, E) and one practice scenario (D). Typical background noises such as are caused by weather, noisy sensors, artillery, and aircraft were not eliminated. All scenarios contained approximately the same number of targets. Table 1 shows the exact number of targets per half-hour segment in each scenario. Over 90% of the targets were vehicles, in groups of 1 to 9. Vehicle drivers were given orders to travel at a given speed, in most cases 10, 15, or 20 miles per hour.

Table 1

DISTRIBUTION OF TARGETS BY SCENARIO SEGMENTS

	Scenario					
Segment	A	B	C	E	D	Target Density
1st half hour	4	3	4	4	4	Low
2nd half hour	9	10	11	10	7	High
3rd half hour	2	5	3	2	3	Low
4th half hour	13	10	9	14	9	High
Total	28	28	27	30	23	

Procedure

Four operators at a time were given a general briefing explaining the purpose of the research and what their roles would be. They were given two hours of instruction and practice on the various displays (Appendix D). They also practiced reporting target activations, using the prepared forms. Following a one-hour lunch break, the operators returned for their first two-hour testing session. On the morning of the following day, the group returned for their second testing session. The third and fourth sessions were held in the afternoon. The last two sessions were separated by a 10-minute break. The complete testing schedule is shown in Appendix C. At each session, subjects worked on a different display and scenario.

All subjects used the two report forms (Appendixes A and B) to record target information. One form (Green) was used to report activation on the left half of the display (Sensor Field 1), and the other (Blue) was used to report activations on the right half of the display (Sensor Field 2).

Some equipment failures and human errors occurred during testing, but a record of these was kept for consideration in subsequent scoring. These disruptions included:

1. A malfunctioning lamp circuitry in two displays--the situation map display with blinking lights and the situation map display with an exponential lamp driver circuit. Testing was discontinued and resumed when circuitry was repaired, and subjects were rescheduled.

2. The RO-376 X-T plotter drive mechanism stopped several times during testing. Experimenters repaired the mechanisms, reset clocks, and resumed testing.

3. Several subjects were unable to attend their scheduled sessions. Experimenters rescheduled all subjects so that no experimental cells went unfilled.

RESULTS

Target Detections

Displays. Table 2 shows the mean number of correct target detections for each of the four displays. The differences between displays were not statistically significant (Table 3). In spite of the operators' greater familiarity with the RO-376 and the availability of a permanent record with its use, performance was not superior to that obtained with the situation map displays.

Table 2

MEAN TARGET DETECTION SCORES BY DISPLAY

Display	Mean Scores
RO-376	14.87
Blinking lights	15.25
Exponential lights	16.75
Exponential lights with compressed time	16.87

Table 3

ANALYSIS OF VARIANCE SUMMARY--TARGETS DETECTED

Source	df	SS	MS	F	Significance Level
Between Subjects	15	371.6250			
Experience	1	72.0000	72.000	3.3642	NS
Subj W. E = e1	14	299.6250	21.4018		
Within	112	1506.2500			
Period	3	12.9375	4.3125	1.0826	NS
Display	3	25.1250	8.3750	2.1025	NS
Scenario	3	6.7500	2.2500	0.5649	NS
Experience X Period	3	17.0625	5.6875	1.4278	NS
Experience X Display	3	12.2500	4.0833	1.0251	NS
Experience X Scenario	3	5.6250	1.8750	0.4707	NS
Residual = e2	30	119.5000	3.9833		
Activity (Lo-Hi)	1	892.5312	892.5312	66.8428	.01
Activity X Experience	1	38.2813	38.2813	2.8669	NS
Activity X (Subj W. E) = e3	14	186.9375	13.3527		
Activity X Period	3	2.9063	0.9688	0.3131	NS
Activity X Display	3	21.5938	7.1979	2.3266	NS
Activity X Scenario	3	27.5937	9.1979	2.9730	.05
Activity X Experience X Period	3	23.9062	7.9687	2.5757	NS
Activity X Experience X Display	3	8.0937	2.6979	0.8720	NS
Activity X Experience X Scenario	3	12.3437	4.1146	1.3300	NS
Residual = e4	30	92.8125	3.0938		

Activity Level. Table 4 shows the mean detection scores for the two activity levels. Although the average number of detections during high activity was significantly greater than during low activity (Table 3), the average number of targets presented was also greater during high activity. Thus, the ratio of detected targets over presented targets was lower for the high activity period. The detection ratios are different at the .001 level, using the Chi square test for significance. The lower detection ratio for the high activity condition can be attributed to "operator overload" and "target overlap." "Operator overload" refers to inadequate time for the operator to interpret all the sensor activations presented and to prepare the required target reports. "Target overlap" refers to simultaneous or immediately successive activation of sensors by different targets. In such instances, the signals caused by one target may be embedded in the signal pattern generated by another target, so that the targets are difficult to detect.

Table 4

MEAN DETECTION SCORES BY ACTIVITY LEVEL

	Targets Detected (per scenario)	Targets Presented (per scenario)	Detected / Presented
High Activity	10.6	21.50	.47
Low Activity	5.3	6.75	.79

Scenarios. No significant differences were found between scenarios, indicating that the difficulty of detecting targets of the four test scenarios was similar.

The interaction between activity and scenarios was statistically significant at the .05 level. This interaction may be an artifact attributable to differences in the number of targets in the low and high activity segments of the scenarios. While the total number of targets varied little among the scenarios, the scenarios having the lowest number of targets in the low activity segments (A and E) had the highest number of targets in the high activity segment. Since the experimental design balanced scenarios across displays and order of presentation, scenario inequality did not affect the results of primary interest. Table 5 shows the total targets detected during each activity level of the four scenarios.

Table 5

TOTAL DETECTION SCORES BY ACTIVITY LEVEL BY SCENARIO

	Scenario				
Activity Level	A	B	C	E	Total Score
Low	82	87	92	80	341
High	167	172	155	185	679
Total Score	249	259	247	265	

False Alarms

Table 6 shows the mean number of false alarms on the four displays. Subjects reported a greater number of false alarms while monitoring each of the three situation map displays than while monitoring the RO-376. The differences between displays was not statistically significant (Table 7). Table 8 contains a breakdown of the mean number of false alarms by time period. The differences between periods was statistically significant at the .05 level (Table 7). No simple explanation for this difference is apparent. A combination of learning, motivation, and fatigue effects may have contributed to these results. Neither the activity variable nor the scenario variable showed significant differences. The interaction between these two variables was found to be significant at the .05 level.

Table 6

MEAN FALSE ALARM SCORES BY DISPLAY

Display	Mean score
RO-376	9.62
Blinking lights	11.81
Exponential lights	11.00
Exponential lights with compressed time	13.44

Table 7

ANALYSIS OF VARIANCE SUMMARY--FALSE ALARMS

Source	df	SS	MS	F	Significance Level
Between Subjects	15	37779.7188			NS
Experience	1	34.0313	34.0313	0.1271	
Subject W. E = e1	14	3745.6875	267.5491		
Within	112	2043.2500			
Period	3	250.2813	83.4271	3.7103	.05
Display	3	60.9063	20.3021	0.9029	NS
Scenario	3	7.5938	2.5313	0.1126	NS
Experience X Period	3	10.1562	3.3854	0.1506	NS
Experience X Display	3	99.6562	33.2187	1.4773	NS
Experience X Scenario	3	123.0937	41.0312	1.8248	NS
Residual = e2	30	674.5625	22.4854		
Activity (Lo-Hi)	1	78.1250	78.1250	4.2725	NS
Activity X Experience	1	1.1250	1.1250	0.0615	NS
Activity X (Subj W. E) e =3	14	256.0000	18.2857		
Activity X Period	3	10.0625	3.3542	0.3298	NS
Activity X Display	3	18.4375	6.1458	0.6043	NS
Activity X Scenario	3	91.1250	30.3750	2.9865	.05
Activity X Exp. X Period	3	1.9375	0.6458	0.0635	NS
Activity X Exp. X Display	3	44.4375	14.8125	1.4564	NS
Activity X Exp. X Scenario	3	10.6250	3.5417	0.3482	NS
Residual = e4	30	305.1250	10.1708		

Table 8

MEAN FALSE ALARM SCORES BY PERIOD

Period	Mean Score
1	8.75
2	16.07
3	9.81
4	11.25

Table 9 shows the total number of false alarms reported during each activity level of the four scenarios. Although whole scenarios were relatively similar in difficulty, individual activity periods did differ significantly across scenarios. Variation in false alarms was greatest between the low activity segments of the various scenarios. Less difference in number of false alarms occurred during high activity periods. Note that scenario B had the least number of false alarms reported during low activity and the most reported during high activity, while the opposite was true for scenario C. It is possible that target patterns were more dissimilar during the various low activity periods than during high activity periods; consequently, monitors responded less consistently with respect to false alarms.

Percent Accuracy

Table 10 shows the percent accuracy for each of the four displays. The difference in accuracy was not statistically significant for the displays (Table 11). Table 12 shows the percent accuracy for activity levels. Monitors were able to function with a greater degree of accuracy during periods of high activity than during periods of low activity. Table 11 shows that this difference was significant at the .01 level.

Table 9

FALSE ALARM SCORES BY ACTIVITY LEVEL BY SCENARIO

Activity Level	Scenario A	B	C	E	Total Score
Low	71	57	103	86	317
High	113	115	91	98	417
Total Score	184	172	194	184	

Table 10

PERCENT ACCURACY ON DISPLAYS

Display	% Accuracy
RO-376	60.82
Blinking lights	56.35
Exponential lights	60.48
Exponential lights with compressed time	55.79

Table 11

ANALYSIS OF VARIANCE SUMMARY--PERCENT ACCURACY

Source	df	SS	MS	F	Significance Levels
Between Subjects	15	41476.7187			
Experience	1	1092.7812	1092.7812	0.3842	NS
Subject W. E = e1	14	40383.9375	2884.5670		
Within	112	25104.2500			
Period	3	1181.9062	393.9687	1.7357	NS
Display	3	1101.5312	362.1771	1.6177	NS
Scenario	3	184.2812	61.4271	0.2706	NS
Experience X Period	3	774.5313	258.1771	1.1375	NS
Experience X Display	3	155.4063	51.8021	0.2282	NS
Experience X Scenario	3	1263.2813	421.0938	1.8552	NS
Residual = e2	30	6809.3125	226.9771		
Activity (Lo-Hi)	1	3423.7812	3423.7812	62.3771	.01
Activity X Experience	1	294.0313	294.0313	5.3569	.05
Activity X (Subj W. E) = e3	14	768.4375	54.8884		
Activity X Period	3	688.5313	229.5104	1.5489	NS
Activity X Display	3	602.1563	200.7188	1.3546	NS
Activity X Scenario	3	1478.2813	492.7604	3.3255	.05
Activity X Exp. X Period	3	1182.6562	394.2187	2.6605	NS
Activity X Exp. X Display	3	454.0312	151.3437	1.0214	NS
Activity X Exp. X Scenario	3	296.7812	98.9271	0.6676	NS
Residual = e4	30	4445.3125	148.1771		

Table 12

PERCENT ACCURACY BY TARGET ACTIVITY LEVEL

	% Accuracy
High Activity	61.95
Low Activity	51.91

Table 13 shows the average percent accuracy for both levels of experience. These results suggest that experience does not improve overall accuracy. The more experienced operators made more correct responses and also reported more false alarms than did the less experienced operators, thus obtaining nearly identical accuracy scores. Table 11 indicates that differences on the experience variable were not statistically significant. However, the interaction of experience and activity level was statistically significant. Table 14 shows the percent accuracy for the two levels of experience at both activity levels. This table clarifies the nature of the significant interaction between experience level and target activity. Although overall accuracy was nearly identical for the two experience levels, the more experienced operators were more accurate during high activity and less accurate during low activity than the less experienced operators. Table 15 shows the percent accuracy for both activity levels of all scenarios.

Table 13

PERCENT ACCURACY BY EXPERIENCE LEVEL

	% Accuracy
High Experience	58.24
Low Experience	58.04

Table 14

PERCENT ACCURACY FOR ACTIVITY BY EXPERIENCE LEVELS

Activity Level	Experience High	Experience Low
High	63.18	60.44
Low	50.03	54.32

Table 15

PERCENT ACCURACY BY SCENARIO BY ACTIVITY LEVEL

Activity Level	Scenario A	B	C	E
Low	53.94	60.70	47.49	48.47
High	59.81	60.13	63.25	65.59

A significant (.05) interaction of activity and scenarios was found for percent accuracy. No significant results were found between scenarios; however, when activity levels within the scenarios are compared, some differences are observed. Percent accuracy during high activity periods for all scenarios was similar. Percent accuracy during low activity periods across scenarios showed greater variation, probably causing the significant interaction effect. Dissimilarities of targets during these low activity periods would appear to account for the difference in performance accuracy.

Target Direction

A direction response was scored correct if a monitor reported the actual route of a given target. Table 16 shows the mean number of correct direction scores for the four displays. The difference between displays was not statistically significant (Table 17). Table 18 shows the mean direction score and direction completeness score (direction score divided by total possible direction score) for both target activity levels. An analysis of variance (Table 17) indicated that

the differences for activity level were significant at the .01 level. However, the significantly greater number of correct direction reports during high activity periods was due almost entirely to the greater number of targets present, as evidenced by the direction completeness scores in Table 18.

Table 16

MEAN DIRECTION SCORES BY DISPLAY

Display	Mean Score
RO-376	3.44
Blinking lights	3.81
Exponential lights	4.06
Exponential lights with compressed time	2.37

CONCLUSIONS AND DISCUSSION

The results on all four performance measures comparing displays are consistent: No significant differences were found. This finding strongly indicates relative equality among displays. With a minimal amount of training, monitors were able to perform as well on the situation map displays as on the RO-376 for which they had received substantially more training and experience.

However, all field data in this experiment were collected on an area deployment test. None of the monitors had had previous experience with this particular deployment technique. An area deployment familiarization briefing was provided prior to this experiment, but monitors had difficulty working with this new concept. It may be inferred that performance scores decreased because of use of this deployment technique since the monitoring task is more difficult and less familiar than that for string deployment.

Recurring significant results were obtained in the analysis of the target activity variable. Most of this variance is attributable to the unequal number of targets presented in the two activity periods.

Table 17

ANALYSIS OF VARIANCE SUMMARY--TARGET DIRECTION

Source	df	SS	MS	F	Significance Level
Between Subjects	15	60.6797			
Experience	1	2.2578	2.2578	0.5410	NS
Subject W. E = e1	14	58.4219	4.1730		
Within	112	243.6250			
Period	3	0.6458	0.2162	1.1127	NS
Display	3	13.2735	4.4245	2. 3066	NS
Scenario	3	1.9610	0.6537	0.3408	NS
Experience X Period	3	2.9609	0.9870	0.5145	NS
Experience X Display	3	0.8359	0.2786	0.1452	NS
Experience X Scenario	3	1.8984	0.6328	0.3299	NS
Residual = e2	30	57.5468	1.9182		
Activity (Lo-Hi)	1	59.1328	59.1328	27.7254	.01
Activity X Experience	1	0.3829	0.3829	0.1795	.NS
Activity X (Subj W. E) = e3	14	29.8593	2.1328		
Activity X Period	3	3.0859	1.0286	0.5587	NS
Activity X Display	3	5.5859	1.8620	1.0113	NS
Activity X Scenario	3	4.0234	1.3411	0.7284	NS
Activity X Exp. X Period	3	3.9609	1.3203	0.7171	NS
Activity X Exp. X Display	3	0.7109	0.2370	0.1287	NS
Activity X Exp. X Scenario	3	2.5234	0.8411	0.4568	NS
Residual = e4	30	55.2346	1.8412		

Table 18

MEAN DIRECTION AND DIRECTION COMPLETENESS
SCORES BY ACTIVITY LEVEL

	Mean Scores	
	Mean Direction	Direction Completeness
High Activity	3.42	.159
Low Activity	1.03	.153

Table 19 summarizes total performance measure scores for each of the four displays used in the present experiment. This experiment is the first systematic work undertaken using the area deployment technique. Consequently, the parameter data obtained provide the only such information currently available as of the publication of the present technical paper.

Table 19

PARAMETER SUMMARY

	DISPLAYS				
	RO-376	BLINKING LIGHTS	EXPONENTIAL LIGHTS	EXPONENTIAL LIGHTS WITH COMPRESSED TIME	AVERAGE
Total Targets Presented	452	452	452	452	452
Total Targets Detected	238	244	268	270	255
Percentage of Targets Detected	52.65	53.98	59.29	59.73	56.47
Total False Alarms	154	189	176	215	183.5
Percent Accuracy	60.82	56.35	60.48	55.79	58.15
Total Target Direction Score	55	61	65	38	54.75
Total Target Direction Percentage	12.17	13.50	14.38	8.41	12.11

APPENDIXES

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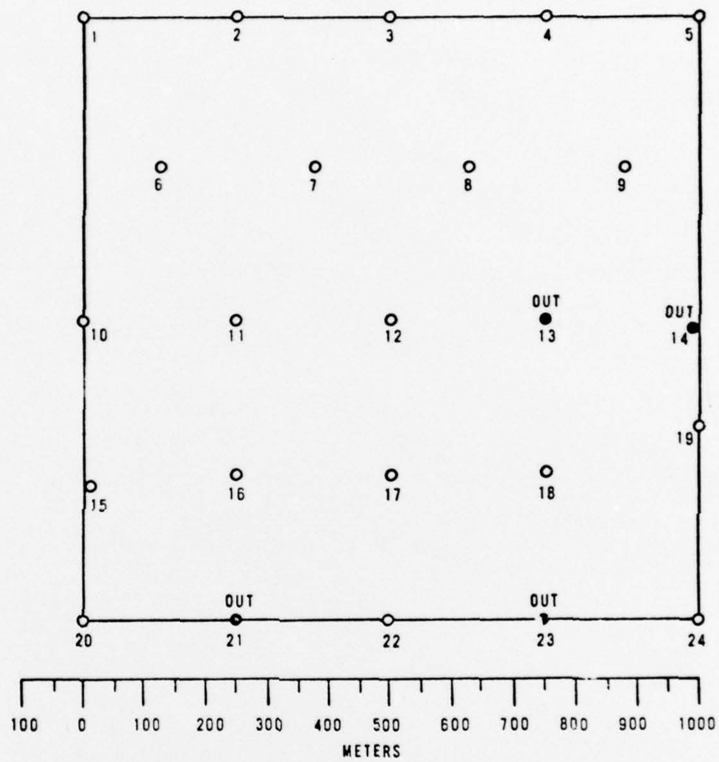
APPENDIX A TARGET LOG, SENSOR FIELD 1

SUBJECT* ______________

DISPLAY ______________

SCENARIO ______________

FIELD 1
TARGET LOG



TARGET NUMBER	FIRST ACTIVATED SENSOR	TIME OF FIRST ACTIVATED SENSOR	LAST ACTIVATED SENSOR	TIME OF LAST ACTIVATED SENSOR	ESTIMATED DISTANCE	SPEED	TARGET CONFIDENCE

APPENDIX B

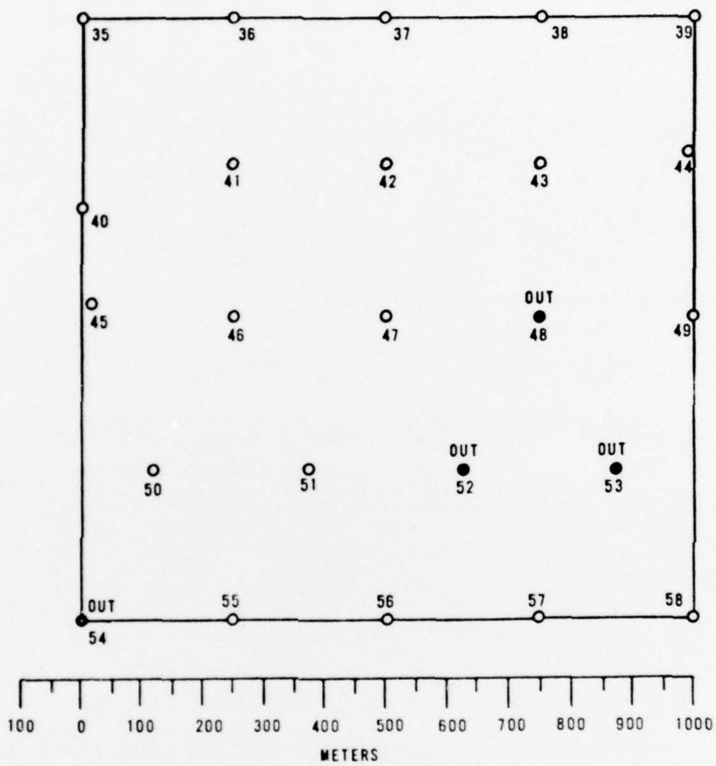
TARGET LOG, SENSOR FIELD 2

SUBJECT# ____________

DISPLAY ____________

SCENARIO ____________

FIELD 2
TARGET LOG



TARGET NUMBER	FIRST ACTIVATED SENSOR	TIME OF FIRST ACTIVATED SENSOR	LAST ACTIVATED SENSOR	TIME OF LAST ACTIVATED SENSOR	ESTIMATED DISTANCE	SPEED	TARGET CONFIDENCE

APPENDIX C GRECO-LATIN SQUARE DESIGN

SUBJECT	1st TWO HR. SESSION	2nd TWO HR. SESSION	3rd TWO HR. SESSION	4th TWO HR. SESSION
1	XT A	EX B	CT C	BL E
2	CT A	BL B	XT C	EX E
3	BL B	CT A	EX E	XT C
4	EX B	XT A	BL E	CT C
5	EX C	XT E	BL A	CT B
6	BL C	CT E	EX A	XT B
7	CT E	BL C	XT B	EX A
8	XT E	EX C	CT B	BL A
9	EX B	XT A	BL E	CT C
10	BL B	CT A	EX E	XT C
11	CT A	BL B	XT C	EX E
12	XT A	EX B	CT C	BL E
13	EX C	XT E	BL A	CT B
14	BL C	CT E	EX A	XT B
15	CT E	BL C	XT B	EX A
16	XT E	EX C	CT B	BL A

A - Scenario A
B - Scenario B
C - Scenario C
E - Scenario E

XT - R0376
EX - Map Display with Exponential Lights
CT - Map Display with Exponential Lights and Compressed Time
BL - Map Display with Blinking Lights

APPENDIX D TEXT FOR PRETEST BRIEFING AND RESPONSE REQUIREMENTS

PRE-EXPERIMENT BRIEFING

I am Mr. Edwards, a research psychologist with HRB-Singer, Inc. Dr. Shvern is a project psychologist from the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), the organization responsible for this effort. Mr. Parker is an electronics specialist from the Army Electronics Command at Fort Monmouth, New Jersey.

Our purpose in coming here is to evaluate, with your assistance, four types of unattended ground sensor displays. Some of you may have participated in a similar effort here last year. This is a follow-on to that study. The Navy is again cooperating in the effort because of their interest in the development of improved UGS displays, and your Command has arranged for your participation. Your task in the experiment will be to act as a sensor operator in a number of different situations using different display devices. Many of the skills you have acquired in school and on the job will apply to these tasks; however, some of the displays will be new to you, and details such as measurement and reporting procedures will differ. In these cases, training and instructions will be provided. If at any time during your work with us, you do not understand something or you are not sure of what you are to do - - - ASK. You will not be penalized and asking might prevent your having to repeat some of your work. If any of the equipment appears to be malfunctioning, inform one of us immediately.

Previous studies of this kind have dealt primarily with sensor strings emplaced along roads, trails, or other infiltration routes. Here, we are applying seismic sensors to an area intrusion problem. In such a situation, we would have sensor fields emplaced over a wide geographical area that an enemy force would utilize should he elect to maneuver his forces cross country and not along the existing road network. Such a situation could be expected in a mid-intensity conflict in Western Europe. This type of sensor field would be used to detect and identify different tactical maneuvers such as reconnaissance probes, feints, or major attacks, and is referred to as a Gated Array.

For our experiment, we have taped actual sensor activations from a Gated Array during a field exercise at Fort Bragg, North Carolina. The tapes include signatures of individual and groups of tanks, APC's, trucks, jeeps, and personnel collected under simulated battlefield conditions complete with noise such as artillery fire, helicopters, and wind. These tapes will be played back to activate the four display devices. You will interpret the displays and extract information using our procedures and forms. Since we know where and when target activations actually occurred, we can score your reports for accuracy and thereby determine which display device operators can best use in this particular situation.

Each of you will work on the experiment for about 2 days. During that time, you will be given training on the new display equipment and a practical exercise to familiarize you with the test situation. Then, you will work with each type of display for two hours each with appropriate breaks, lunch, etc. If you cannot be here during the time presently scheduled, tell us now so we can reschedule you. You must be here for all scheduled times or we cannot use your results. Here is your schedule for the experiment.

Now about the displays. The first, the RO-376 Event Recorder, you have trained on and have worked with in the field. This will be the standard display since it is the present operational device. Your reports using this device will be compared to your results with the other devices. Training on the RO-376 will be minimal since this device should be familiar to you.

The second display is a situation map display with blinking lights. This display consists of a map with lights indicating the location of the sensors. Each sensor activation causes the corresponding light to blink for five seconds. Thus, you can see the progression of the enemy on the map by which light is blinking.

The third device is also a situational map display. This display differs from the former only in the activation of the lamps and is referred to as the exponential lamp display. When a sensor is activated, the first activation will energize the lamp and cause it to glow faintly. If no more activations occur, the dimly glowing lamp will gradually extinguish. However, with successive activations of the sensor, the lamp will begin to glow more brightly until it reaches a maximum and will remain at the maximum as long as activations occur. When no more activations occur, the lamp will gradually grow dim and finally extinguish.

The fourth display is identical to the situation map display with exponential lamps above except that you have a review or playback capability. With the situation map display, you have no permanent record or way of checking on your decisions like you do with the RO-376. However, if, in the field, there was a tape recorder to record the activations, then you could play them back if you wished to see the activations a second time. In addition, if you play the recording back at 10 times normal speed, you would, in a sense, compress time and be able to review more quickly. This, then, is your fourth display--a situation map display which allows you to play back what has happened in the past, at 10 times normal speed. As an additional condition of this display, every half hour you will have a required review of what has occurred during the previous half hour but in 10 times normal speed. This forced review is another approach we are trying out.

Your task, then, with this fourth display will be to interpret the blinking lights, which represent activations in the field, on the map display exactly like the third display. However, if you wish to review what you thought to be a target pattern activation, you would so indicate. We will stop the clock and replay in 10 times normal speed the last few minutes of activations. For the purposes of this experiment, we would pretend no time elapsed during this playback. When the review is over, you would once again view the display in normal time. Then after one-half hour (of clock time) is over, you would have mandatory review of the entire period. Are there any questions to this point?

What you will be seeing will be targets recorded during the maneuvers at Fort Bragg. For our purposes, a target will be an individual person or vehicle or a group of personnel or vehicles traveling together. Vehicle group size will range from two to a maximum of nine. Personnel groups may range from 5 to 100 individuals. Let me emphasize that ojects traveling in groups are to be reported as one target. Thus, a column of nine trucks will be reported as one target.

In all cases, you will be working with two separate sensor fields. On the map they are located - - - (point out on map). (Figure D-1.) Each field contains 24 sensors (20 of which are active), implaced in a gated pattern. Field 1 sensors are numbered 1 through 24 on the map displays and appear on the corresponding channels on the RO-376. Field 2 sensors are numbered 35 through 58 on both map and X-T displays.

(Pass out sample target logs.) This is the Target Log you will be using to report your detections. There are two forms, one for each field. Field 1 will always appear to the left on the map and X-T displays, and targets detected there will always be reported on the green (Field 1) logs. Targets detected in Field 2 (always on the right side) will be reported on the blue forms.

At the top of each target log is a place for you to fill in your subject number, the display you are using, and the scenario (or tape) you are working on. The test monitor will give you this information prior to each session. Make certain it appears on each log sheet. Each scenario may contain more than 20 or 30 targets, so you will be using a number of log sheets in each session.

On the upper part of the log is an implant sketch of the sensors in each field. Note again that Field 1 contains sensors 1 - 24 and Field 2 sensors 35 - 58. You are to use this matrix to make notes of sensor activations. Let me stress that we want you to make your notes on the implant sketch rather than on the map display overlay or X-T plot. We also want you to trace the path of each target by noting sensor activations at various points in the field. We will cover that procedure in detail when we get to the practice tape. Below the sketch is a distance scale to be used in measuring distances on the sketch.

The bottom of the log contains the space for the actual recording of target information.

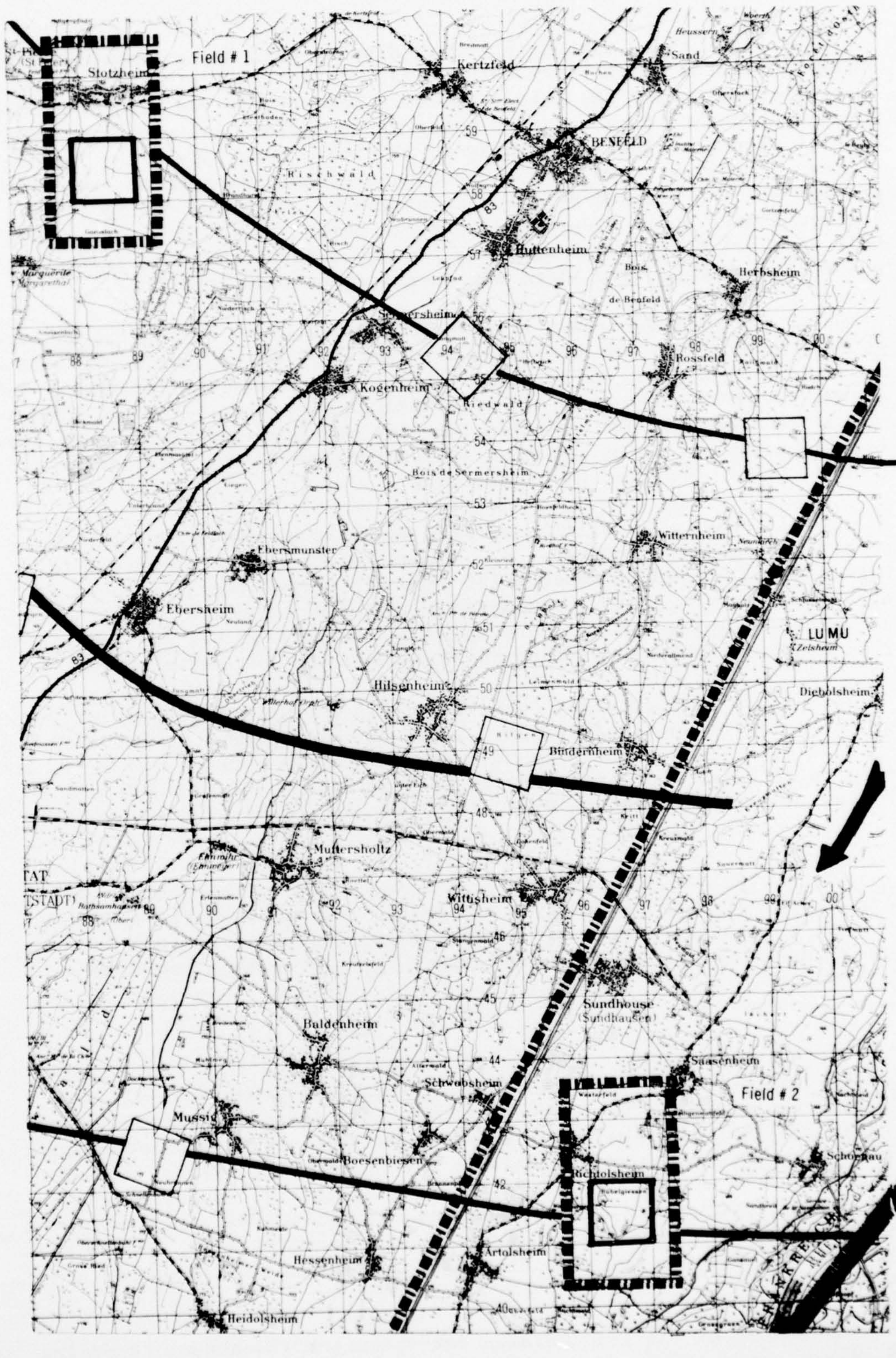


Figure D-1. Orientation map

1. Target Number - Here you will number the targets you detect in each field. Those targets you detect in Field 1 will be recorded on the green logs and will be numbered 1 through whatever the total number of targets you detect in Field 1 turns out to be. Targets detected in Field 2 will be recorded on the blue logs and numbered 1 through --.

2. First Activated Sensor - In this column you will write the number at the first sensor in the field activated by the target. (Show Example)

3. Time of First Activated Sensor - In this column you will enter the time when you establish that a valid activation has occurred.

a. For the X-T display, this will be the time of the third pen activation.

b. For the map display with blinking lights, this will be the time of the third lamp activation.

c. For the map display with exponential lamps, this will be when the lamp reached full intensity.

d. For the map display with review capability, if you are operating in compressed time, this will be when the lamp reached full intensity. In this case you will not be able to use clock time. If you wish to record time during this period, say loudly to the operator "TIME". He will tell you the tape recorder counter numbers which you will write in the time column of the log. We will later convert these numbers to real time and make the speed calculation in this condition. You may also tell the operator to stop if you wish to fill in the answer sheet.

4. Last Activated Sensor - Record in this column the number of the last sensor in the field activated by the target.

5. Time of Last Activated Sensor - This time will be recorded using the same ground rules as the time of first activation.

6. Estimated Distance - You will measure this distance (in meters) from the path of the target you have traced on the sketch.

7. Speed - You will calculate speed using the time difference (in minutes) between the first activated sensor and the last activated sensor and the distance (in meters). For this, round time to the nearest minute, round distance to the nearest 100 meters, and use the calculation table provided (Figure D-2).

8. Target Confidence - Answer the question, "How confident are you that this is a valid target." Use these guidelines:

Extremely Confident	- 90 - 100%
Confident	- 70 - 80%
Uncertain	- 40 - 60%
Doubtful	- 0 - 30%

(Meters per Minute)

MINUTES

	1	2	3	4	5	6	7	8	9	10	11	12	13
100	100	50	33	25	20	17	14	12	11	10	9	8	8
200	200	100	67	50	40	33	29	25	22	20	18	17	15
300	300	150	100	75	60	50	43	37	33	30	27	25	23
400	400	200	133	100	80	67	57	50	44	40	36	33	31
500	500	250	167	125	100	83	71	62	56	50	45	42	38
600	600	300	200	150	120	100	86	75	67	60	55	50	46
700	700	350	233	175	140	117	100	87	78	70	64	58	54
800	800	400	267	200	160	133	114	100	89	80	73	67	62
900	900	450	300	225	180	150	129	112	100	90	82	75	69
1000	1000	500	333	250	200	167	143	125	111	100	91	83	77
1100	1100	550	367	275	220	183	157	137	122	110	100	92	85
1200	1200	600	400	300	240	200	171	150	133	120	109	100	92
1300	1300	650	433	325	260	217	186	162	144	130	118	103	100
1400	1400	700	467	350	280	233	200	175	156	140	127	117	108
1500	1500	750	500	375	300	250	214	187	167	150	136	125	115
1600	1600	800	533	400	320	267	229	200	178	160	145	133	123
1700	1700	850	567	425	340	283	243	212	189	170	155	142	131
1800	1800	900	600	450	360	300	257	225	200	180	164	150	138
1900	1900	950	633	475	380	317	271	237	211	190	173	158	146
2000	2000	1000	667	500	400	333	286	250	222	200	182	167	154
2100	2100	1050	700	525	420	350	300	262	233	210	191	175	162
2200	2200	1100	733	550	440	367	314	275	244	220	200	183	169
2300	2300	1150	767	575	460	383	329	287	256	230	209	192	177
2400	2400	1200	800	600	480	400	343	300	267	240	218	200	185
2500	2500	1250	833	625	500	417	357	312	278	250	227	208	192

	14	15	16	17	18	19	20	21	22	23	24	25
100	7	7	6	6	6	5	5	5	5	4	4	4
200	14	13	12	12	11	11	10	10	9	9	8	8
300	21	20	19	18	17	16	15	14	14	13	12	12
400	28	27	25	24	22	21	20	19	18	17	17	16
500	35	33	31	29	28	26	25	24	23	22	21	20
600	43	40	37	35	33	32	30	29	27	26	25	24
700	50	47	44	41	39	37	35	33	32	30	29	28
800	57	53	50	47	44	42	40	38	36	35	33	32
900	64	60	56	53	50	47	45	43	41	39	37	36
1000	71	67	62	59	56	53	50	48	45	43	42	40
1100	78	73	69	65	61	58	55	52	50	48	46	44
1200	85	80	75	71	67	63	60	57	55	52	50	48
1300	93	87	81	76	72	68	65	62	59	57	54	52
1400	100	93	87	82	78	74	70	67	64	61	58	56
1500	107	100	94	88	83	79	75	71	68	65	62	60
1600	114	107	100	94	89	84	80	76	73	70	67	64
1700	121	113	106	100	94	89	85	81	77	74	71	68
1800	128	120	112	106	100	95	90	86	82	78	75	72
1900	135	127	119	112	106	100	95	90	86	83	79	76
2000	143	133	125	118	111	105	100	95	91	87	83	80
2100	150	140	131	124	117	111	105	100	95	91	87	84
2200	157	147	137	129	122	116	110	105	100	96	92	88
2300	164	153	144	135	128	121	115	110	105	100	96	92
2400	171	160	150	141	133	126	120	114	109	104	100	96
2500	178	167	156	147	137	132	125	119	114	109	104	100

Figure D-2. Speed table

RESPONSE REQUIREMENTS

OUTLINE

A. General

B. Review of Steps

A. GENERAL

To determine target course direction through the sensor field, and distance traveled, it will be necessary for you to use your judgment. Since we are interested in considering targets which traverse the entire array (field), the notations of "valid" sensor activations, when connected by a line, should portray the generalized route of the target through the area.

Since it cannot be determined from the available sensor data how far each target passed from a given sensor, it will not be possible to determine the precise path followed. However, a fairly accurate route can be developed by using a "curve-fitting" technique. This involves smoothing out sharp angles resulting from connecting these sensors.

The start and end points of the route (recorded for time and distance determination) can be selected by noting the points at which the approximate route crossed the first sensor row, and the corresponding point when the route passes through the last row of sensors. These can be called points "A" and "B" respectively.

The length of the route can be obtained by using a paper edge to record straight line route segments in sequence between points A and B, then determining total length in meters by using the bar scale on the target log form.

Time data is developed from the activation times noted for the sensors nearest points "A" and "B". In virtually every case, this will be the first and last sensor activated by a given target.

B. REVIEW OF STEPS

1. Complete notations on the target log of valid sensor activations, along with appropriate times.

2. Connect in sequence all activated sensors with a light line.

3. Smooth out this line to obtain an approximate route.

4. Mark points A and B where this route enters and leaves the sensor field.

RESPONSE REQUIREMENTS (Continued)

B. REVIEW OF STEPS (Cont'd)

5. Determine route length in meters between points A and B by using a paper edge and the bar scale on the target log. Record this length on the log in the appropriate location.

6. Develop total elapsed times from the sensors nearest points A and B. Record this time on the log.

7. Using the speed table and the data just determined, record the apparent target speed in meters per minute on the target log. Note that times are needed only to the nearest minute, while route length is needed only to the nearest 100 M.

DISTRIBUTION

ARI Distribution List

4 OASD (M&RA)
2 HQDA (DAMI-CSZ)
1 HQDA (DAPE-PBR
1 HQDA (DAMA-AR)
1 HQDA (DAPE-HRE-PO)
1 HQDA (SGRD-ID)
1 HQDA (DAMI-DOT-C)
1 HQDA (DAPC-PMZ-A)
1 HQDA (DACH-PPZ-A)
1 HQDA (DAPE-HRE)
1 HQDA (DAPE-MPO-C)
1 HQDA (DAPE-DW)
1 HQDA (DAPE-HRL)
1 HQDA (DAPE-CPS)
1 HQDA (DAFD-MFA)
1 HQDA (DARD-ARS-P)
1 HQDA (DAPC-PAS-A)
1 HQDA (DUSA-OR)
1 HQDA (DAMO-RQR)
1 HQDA (DASG)
1 HQDA (DA10-PI)
1 Chief, Consult Div (DA-OTSG), Adelphi, MD
1 Mil Asst. Hum Res, ODDR&E, OAD (E&LS)
1 HQ USARAL, APO Seattle, ATTN: ARAGP-R
1 HQ First Army, ATTN: AFKA-OI-TI
2 HQ Fifth Army, Ft Sam Houston
1 Dir, Army Stf Studies Ofc, ATTN: OAVCSA (DSP)
1 Ofc Chief of Stf, Studies Ofc
1 DCSPER, ATTN: CPS/OCP
1 The Army Lib, Pentagon, ATTN: RSB Chief
1 The Army Lib, Pentagon, ATTN: ANRAL
1 Ofc, Asst Sect of the Army (R&D)
1 Tech Support Ofc, OJCS
1 USASA, Arlington, ATTN: IARD-T
1 USA Rsch Ofc, Durham, ATTN: Life Sciences Dir
2 USARIEM, Natick, ATTN: SGRD-UE-CA
1 USATTC, Ft Clayton, ATTN: STETC-MO-A
1 USAIMA, Ft Bragg, ATTN: ATSU-CTD-OM
1 USAIMA, Ft Bragg, ATTN: Marquat Lib
1 US WAC Ctr & Sch, Ft McClellan, ATTN: Lib
1 US WAC Ctr & Sch, Ft McClellan, ATTN: Tng Dir
1 USA Quartermaster Sch, Ft Lee, ATTN: ATSM-TE
1 Intelligence Material Dev Ofc, EWL, Ft Holabird
1 USA SE Signal Sch, Ft Gordon, ATTN: ATSO-EA
1 USA Chaplain Ctr & Sch, Ft Hamilton, ATTN: ATSC-TE-RD
1 USATSCH, Ft Eustis, ATTN: Educ Advisor
1 USA War College, Carlisle Barracks, ATTN: Lib
2 WRAIR, Neuropsychiatry Div
1 DLI, SDA, Monterey
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-WGC
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-MR
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-JF
1 USA Artic Test Ctr, APO Seattle, ATTN: STEAC-MO-ASL
1 USA Artic Test Ctr, APO Seattle, ATTN: AMSTE-PL-TS
1 USA Armament Cmd, Redstone Arsenal, ATTN: ATSK-TEM
1 USA Armament Cmd, Rock Island, ATTN: AMSAR-TDC
1 FAA-NAFEC, Atlantic City, ATTN: Library
1 FAA-NAFEC, Atlantic City, ATTN: Hum Engr Br
1 FAA Aeronautical Ctr, Oklahoma City, ATTN: AAC-44D
2 USA Fld Arty Sch, Ft Sill, ATTN: Library
1 USA Armor Sch, Ft Knox, ATTN: Library
1 USA Armor Sch, Ft Knox, ATTN: ATSB-DI-E
1 USA Armor Sch, Ft Knox, ATTN: ATSB-DT-TP
1 USA Armor Sch, Ft Knox, ATTN: ATSB-CD-AD
2 HQUSACDEC, Ft Ord, ATTN: Library
1 HQUSACDEC, Ft Ord, ATTN: ATEC–EX–E–Hum Factors
2 USAEEC, Ft Benjamin Harrison, ATTN: Library
1 USAPACDC, Ft Benjamin Harrison, ATTN: ATCP–HR
1 USA Comm–Elect Sch, Ft Monmouth, ATTN: ATSN–EA
1 USAEC, Ft Monmouth, ATTN: AMSEL–CT–HDP
1 USAEC, Ft Monmouth, ATTN: AMSEL–PA–P
1 USAEC, Ft Monmouth, ATTN: AMSEL–SI–CB
1 USAEC, Ft Monmouth, ATTN: C, Facl Dev Br
1 USA Materials Sys Anal Agcy, Aberdeen, ATTN: AMXSY–P
1 Edgewood Arsenal, Aberdeen, ATTN: SAREA–BL–H
1 USA Ord Ctr & Sch, Aberdeen, ATTN: ATSL–TEM–C
2 USA Hum Engr Lab, Aberdeen, ATTN: Library/Dir
1 USA Combat Arms Tng Bd, Ft Benning, ATTN: Ad Supervisor
1 USA Infantry Hum Rsch Unit, Ft Benning, ATTN: Chief
1 USA Infantry Bd, Ft Benning, ATTN: STEBC–TE–T
1 USASMA, Ft Bliss, ATTN: ATSS–LRC
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA–CTD–ME
1 USA Air Def Sch, Ft Bliss, ATTN: Tech Lib
1 USA Air Def Bd, Ft Bliss, ATTN: FILES
1 USA Air Def Bd, Ft Bliss, ATTN: STEBD–PO
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Lib
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: ATSW–SE–L
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Ed Advisor
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: DepCdr
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: CCS
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCASA
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACO–E
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACC–CI
1 USAECOM, Night Vision Lab, Ft Belvoir, ATTN: AMSEL–NV–SD
3 USA Computer Sys Cmd, Ft Belvoir, ATTN: Tech Library
1 USAMERDC, Ft Belvoir, ATTN: STSFB–DQ
1 USA Eng Sch, Ft Belvoir, ATTN: Library
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL–TD–S
1 USA Topographic Lab, Ft Belvoir, ATTN: STINFO Center
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL–GSL
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: CTD–MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATS–CTD–MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI–TE
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI–TEX–GS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI–CTS–OR
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI–CTD–DT
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI–CTD–CS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: DAS/SRD
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI–TEM
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: Library
1 CDR, HQ Ft Huachuca, ATTN: Tech Ref Div
2 CDR, USA Electronic Prvg Grd, ATTN: STEEP–MT–S
1 CDR, Project MASSTER, ATTN: Tech Info Center
1 Hq MASSTER, USATRADOC, LNO
1 Research Institute, HQ MASSTER, Ft Hood
1 USA Recruiting Cmd, Ft Sherdian, ATTN: USARCPM–P
1 Senior Army Adv., USAFAGOD/TAC, Elgin AF Aux Fld No. 9
1 HQ USARPAC, DCSPER, APO SF 96558, ATTN: GPPE–SE
1 Stimson Lib, Academy of Health Sciences, Ft Sam Houston
1 Marine Corps Inst., ATTN: Dean–MCI
1 HQUSMC, Commandant, ATTN: Code MTMT 51
1 HQUSMC, Commandant, ATTN: Code MPI–20
2 USCG Academy, New London, ATTN: Admission
2 USCG Academy, New London, ATTN: Library
1 USCG Training Ctr, NY, ATTN: CO
1 USCG Training Ctr, NY, ATTN: Educ Svc Ofc
1 USCG, Psychol Res Br, DC, ATTN: GP 1/62
1 HQ Mid–Range Br, MC Det, Quantico, ATTN: P&S Div

1 US Marine Corps Liaision Ofc, AMC, Alexandria, ATTN: AMCGS–F
1 USATRADOC, Ft Monroe, ATTN: ATRO–ED
6 USATRADOC, Ft Monroe, ATTN: ATPR–AD
1 USATRADOC, Ft Monroe, ATTN: ATTS–EA
1 USA Forces Cmd, Ft McPherson, ATTN: Library
2 USA Aviation Test Bd, Ft Rucker, ATTN: STEBG–PO
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Library
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Educ Advisor
1 USA Aviation Sch, Ft Rucker, ATTN: PO Drawer O
1 HQUSA Aviation Sys Cmd, St Louis, ATTN: AMSAV–ZDR
2 USA Aviation Sys Test Act., Edwards AFB, ATTN: SAVTE–T
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA TEM
1 USA Air Mobility Rsch & Dev Lab, Moffett Fld, ATTN: SAVDL–AS
1 USA Aviation Sch, Res Tng Mgt, Ft Rucker, ATTN: ATST–T–RTM
1 USA Aviation Sch, CO, Ft Rucker, ATTN: ATST–D–A
1 HQ, USAMC, Alexandria, ATTN: AMXCD–TL
1 HQ, USAMC, Alexandria, ATTN: CDR
1 US Military Academy, West Point, ATTN: Serials Unit
1 US Military Academy, West Point, ATTN: Ofc of Milt Ldrshp
1 US Military Academy, West Point, ATTN: MAOR
1 USA Standardization Gp, UK, FPO NY, ATTN: MASE–GC
1 Ofc of Naval Rsch, Arlington, ATTN: Code 452
3 Ofc of Naval Rsch, Arlington, ATTN: Code 458
1 Ofc of Naval Rsch, Arlington, ATTN: Code 450
1 Ofc of Naval Rsch, Arlington, ATTN: Code 441
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Acous Sch Div
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L51
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L5
1 Chief of NavPers, ATTN: Pers-OR
1 NAVAIRSTA, Norfolk, ATTN: Safety Ctr
1 Nav Oceanographic, DC, ATTN: Code 6251, Charts & Tech
1 Center of Naval Anal, ATTN: Doc Ctr
1 NavAirSysCom, ATTN: AIR–5313C
1 Nav BuMed, ATTN: 713
1 NavHelicopterSubSqua 2, FPO SF 96601
1 AFHRL (FT) William AFB
1 AFHRL (TT) Lowry AFB
1 AFHRL (AS) WPAFB, OH
2 AFHRL (DOJZ) Brooks AFB
1 AFHRL (DOJN) Lackland AFB
1 HQUSAF (INYSD)
1 HQUSAF (DPXXA)
1 AFVTG (RD) Randolph AFB
3 AMRL (HE) WPAFB, OH
2 AF Inst of Tech, WPAFB, OH, ATTN: ENE/SL
1 ATC (XPTD) Randolph AFB
1 USAF AeroMed Lib, Brooks AFB (SUL–4), ATTN: DOC SEC
1 AFOSR (NL), Arlington
1 AF Log Cmd, McClellan AFB, ATTN: ALC/DPCRB
1 Air Force Academy, CO, ATTN: Dept of Bel Scn
5 NavPers & Dev Ctr, San Diego
2 Navy Med Neuropsychiatric Rsch Unit, San Diego
1 Nav Electronic Lab, San Diego, ATTN: Res Lab
1 Nav TrngCen, San Diego, ATTN: Code 9000–Lib
1 NavPostGraSch, Monterey, ATTN: Code 55Aa
1 NavPostGraSch, Monterey, ATTN: Code 2124
1 NavTrngEquipCtr, Orlando, ATTN: Tech Lib
1 US Dept of Labor, DC, ATTN: Manpower Admin
1 US Dept of Justice, DC, ATTN: Drug Enforce Admin
1 Nat Bur of Standards, DC, ATTN: Computer Info Section
1 Nat Clearing House for MH–Info, Rockville
1 Denver Federal Ctr, Lakewood, ATTN: BLM
12 Defense Documentation Center
4 Dir Psych, Army Hq, Russell Ofcs, Canberra
1 Scientific Advsr, Mil Bd, Army Hq, Russell Ofcs, Canberra
1 Mil and Air Attache, Austrian Embassy
1 Centre de Recherche Des Facteurs, Humaine de la Defense Nationale, Brussels
2 Canadian Joint Staff Washington
1 C/Air Staff, Royal Canadian AF, ATTN: Pers Std Anal Br
3 Chief, Canadian Def Rsch Staff, ATTN: C/CRDS(W)
4 British Def Staff, British Embassy, Washington
1 Def & Civil Inst of Enviro Medicine, Canada
1 AIR CRESS, Kensington, ATTN: Info Sys Br
1 Militaerpsykologisk Tjeneste, Copehagen
1 Military Attache, French Embassy, ATTN: Doc Sec
1 Medecin Chef, C.E.R.P.A.–Arsenal, Toulon/Naval France
1 Prin Scientific Off, Appl Hum Engr Rsch Div, Ministry of Defense, New Delhi
1 Pers Rsch Ofc Library, AKA, Israel Defense Forces
1 Ministeris van Defensie, DOOP/KL Afd Sociaal Psychologische Zaken, The Hague, Netherlands